Title: METHOD AND DEVICE FOR SUPPRESSING NOISE IN TELEPHONE DEVICES
Applicant: Gerhard Schmidt
Serial No.: 09/914,281
Atty Docket: 1406/14

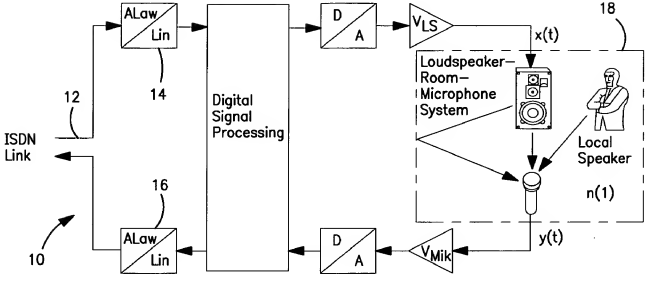

FIG. 1

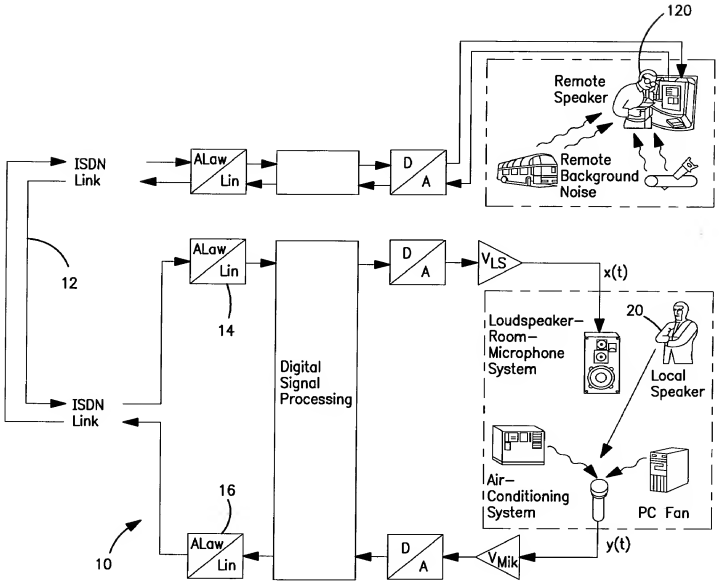
120
Remote
Speaker
Remote
Background
Noise
ISDN
Link
ALaw
Lin
D
A
12
14
Digital
Signal
Processing
V_{LS}
x(t)
Loudspeaker–
Room–
Microphone
System
20
Local
Speaker
Air–
Conditioning
System
PC Fan
y(t)
V_{Mik}
16
10

FIG. 2

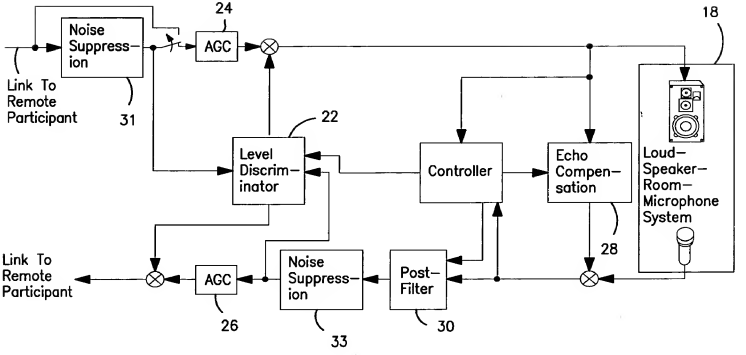
24
18
Noise Suppress-ion
AGC
Link To Remote Participant
31
22
Level Discrim-inator
Controller
Echo Compen-sation
Loud-Speaker-Room-Microphone System
28
Link To Remote Participant
AGC
Noise Suppress-ion
Post-Filter
26
33
30

FIG. 3

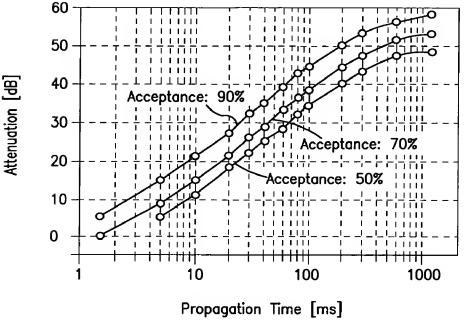
60
50
40
30
20
10
0
Attenuation [dB]
Acceptance: 90%
Acceptance: 70%
Acceptance: 50%
1
10
100
1000
Propagation Time [ms]

FIG. 4

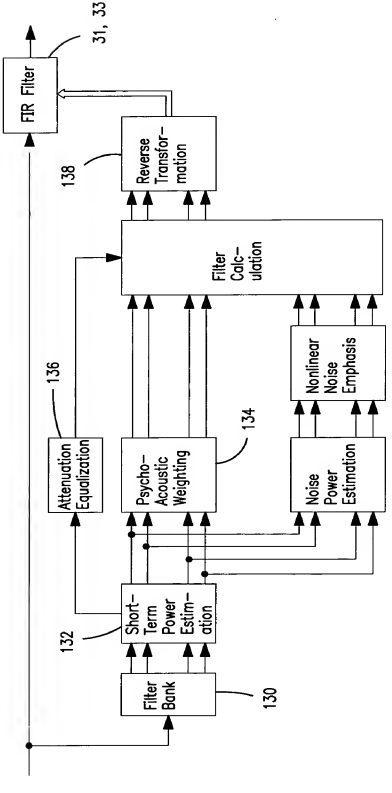
FIR Filter
31, 33
Reverse Transformation
138
Filter Calculation
Nonlinear Noise Emphasis
136
134
Attenuation Equalization
Psycho-Acoustic Weighting
Noise Power Estimation
Short-Term Power Estimation
132
Filter Bank
130

FIG. 5

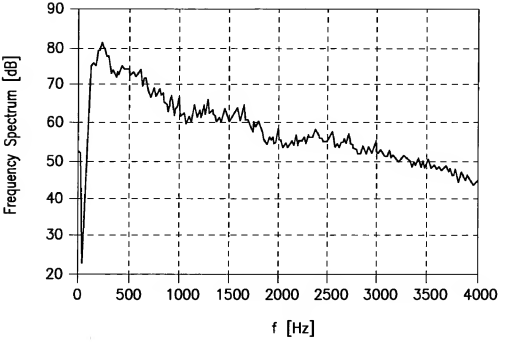
Frequency Spectrum [dB]
90
80
70
60
50
40
30
20
0
500
1000
1500
2000
2500
3000
3500
4000
f [Hz]

FIG. 6

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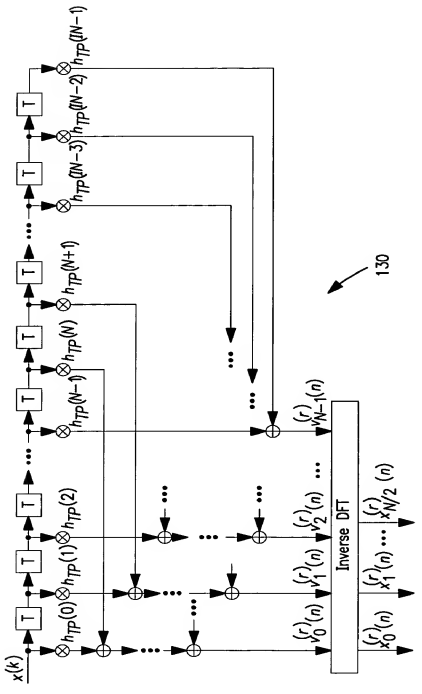

FIG. 7

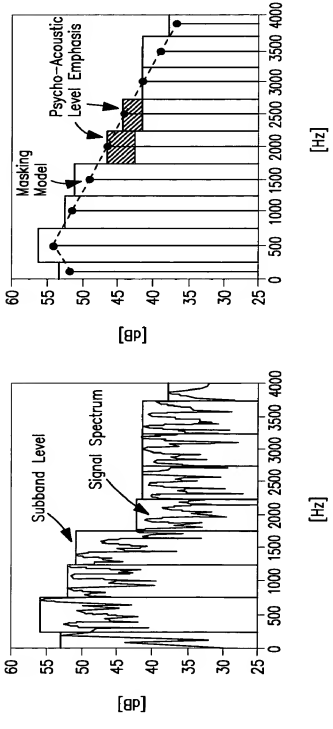
Masking Model
Psycho-Acoustic Level Emphasis
[dB]
[Hz]
Subband Level
Signal Spectrum
[dB]
[Hz]

FIG. 8

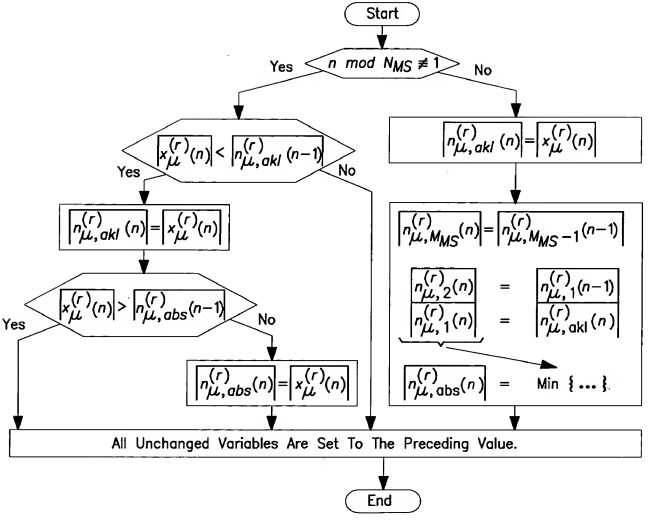
Start
n mod N_MS ≠ 1
Yes
No
|x_μ^(r)(n)| < |n_μ,akl^(r)(n-1)|
Yes
No
|n_μ,akl^(r)(n)| = |x_μ^(r)(n)|
|n_μ,akl^(r)(n)| = |x_μ^(r)(n)|
|x_μ^(r)(n)| > |n_μ,abs^(r)(n-1)|
Yes
No
|n_μ,abs^(r)(n)| = |x_μ^(r)(n)|
|n_μ,M_MS^(r)(n)| = |n_μ,M_MS-1^(r)(n-1)|
n_μ,2^(r)(n) = n_μ,1^(r)(n-1)
n_μ,1^(r)(n) = n_μ,akl^(r)(n)
|n_μ,abs^(r)(n)| = Min { ... }
All Unchanged Variables Are Set To The Preceding Value.
End

FIG. 9

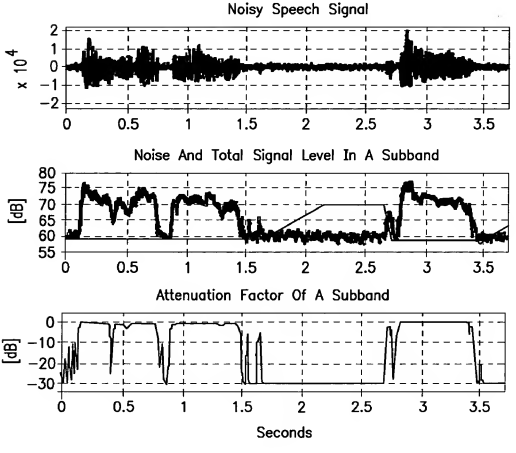
Noisy Speech Signal
x 10^4
2
1
0
−1
−2
0
0.5
1
1.5
2
2.5
3
3.5
Noise And Total Signal Level In A Subband
[dB]
80
75
70
65
60
55
Attenuation Factor Of A Subband
[dB]
0
−10
−20
−30
Seconds

FIG. 10

$$
q(k) \begin{cases}
\begin{bmatrix}
b_o^{(r)}\left(\frac{k}{r}\right) + \frac{2}{N}\sum_{i=1}^{\frac{N}{2}-1} b_i^{(r)}\left(\frac{k}{r}\right)\cos\left(\frac{2\pi}{N} i \frac{N}{2}\right) + b_{\frac{N}{2}}^{(r)}\left(\frac{k}{r}\right)(-1)^{\frac{N}{2}} \\
b_o^{(r)}\left(\frac{k}{r}\right) + \frac{2}{N}\sum_{i=1}^{\frac{N}{2}-1} b_i^{(r)}\left(\frac{k}{r}\right)\cos\left(\frac{2\pi}{N} i\left(\frac{N}{2}-1\right)\right) + b_{\frac{N}{2}-1}^{(r)}\left(\frac{k}{r}\right)(-1)^{\left(\frac{N}{2}-1\right)} \\
\vdots \\
b_o^{(r)}\left(\frac{k}{r}\right) + \frac{2}{N}\sum_{i=1}^{\frac{N}{2}-1} b_i^{(r)}\left(\frac{k}{r}\right)\cos\left(\frac{2\pi}{N} i\right) - b_1^{(r)}\left(\frac{k}{r}\right) \\
b_o^{(r)}\left(\frac{k}{r}\right) + \frac{2}{N}\sum_{i=1}^{\frac{N}{2}-1} b_i^{(r)}\left(\frac{k}{r}\right) + b_0^{(r)}\left(\frac{k}{r}\right) \\
b_o^{(r)}\left(\frac{k}{r}\right) + \frac{2}{N}\sum_{i=1}^{\frac{N}{2}-1} b_i^{(r)}\left(\frac{k}{r}\right)\cos\left(\frac{2\pi}{N} i\right) - b_1^{(r)}\left(\frac{k}{r}\right) \\
\vdots \\
b_o^{(r)}\left(\frac{k}{r}\right) + \frac{2}{N}\sum_{i=1}^{\frac{N}{2}-1} b_i^{(r)}\left(\frac{k}{r}\right)\cos\left(\frac{2\pi}{N} i\left(\frac{N}{2}-1\right)\right) + b_{\frac{N}{2}-1}^{(r)}\left(\frac{k}{r}\right)(-1)^{\left(\frac{N}{2}-1\right)}
\end{bmatrix} & \text{if } k \bmod r = 0 \\
q(k-1) & \text{Otherwise}
\end{cases}
$$

FIG. 11